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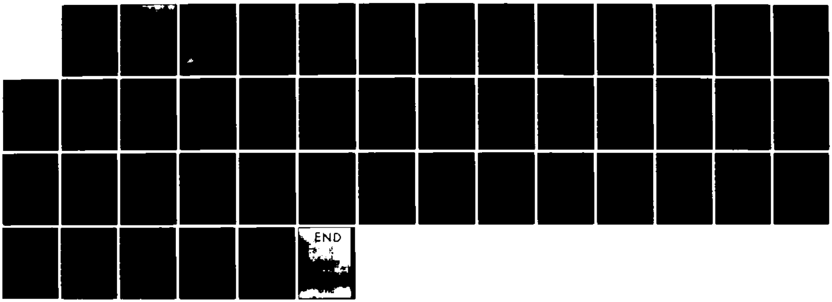

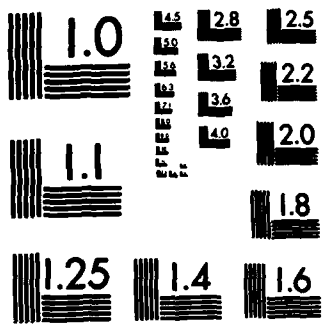

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R & D SUPPORT FOR THE
CENTER FOR SEISMIC STUDIES

QUARTERLY TECHNICAL REPORT

1 JANUARY 1984 - 31 MARCH 1984
AND
1 APRIL 1984 - 30 JUNE 1984

SCIENCE APPLICATIONS, INC.

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R & D SUPPORT FOR THE
CENTER FOR SEISMIC STUDIES

QUARTERLY TECHNICAL REPORT

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SAI
SCIENCE APPLICATIONS, INC.
Post Office Box 1303, 1710 Goodridge Drive, McLean, Virginia 22102, (703) 821-4300

R & D SUPPORT FOR THE
CENTER FOR SEISMIC STUDIES

QUARTERLY TECHNICAL REPORT
FOR THE PERIODS
1 JANUARY 1984 THROUGH 31 MARCH 1984
AND
1 APRIL 1984 THROUGH 30 JUNE 1984

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Work during the second and third quarters of FY1984 continued to be focused on the development of the Center for Seismic Studies, and on planning and developments to prepare for a test of Seismic data exchange and event determination, as proposed by the group of Scientific Experts, UN Committee on Disarmament. A "help" system was designed and partially completed, and other aids for new users of the Center's data and facilities were developed. An introduction to Ingres was prepared, and new experimental data bases were installed.

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1. INTRODUCTION

Work during the second and third quarters of FY 1984 focused on the continuing evaluation, design and development, of the Center for Seismic Studies, and on the conduct of an experiment to test seismic data exchange and event determination in support of the U.S. delegates to the Group of Scientific Experts, U.N. Committee on Disarmament. Highlights of the associated technical accomplishments are described in the following sections of this report.

2. DATA EXCHANGE EXPERIMENTS

2.1 JANUARY, 1984 EXPERIMENT

The technical report for the previous quarter described plans for conducting an experiment to evaluate procedures and capabilities for rapidly exchanging seismic data and extracting epicentral parameters. This planned experiment was conducted for the six days 19-24 January, 1984 following procedures drafted by the Group of Scientific Experts (GSE). The Center performed the functions of both:

(1) a National Data Center (NDC) with the responsibility for reporting signal parameters derived from the nationally designated seismic recording station(s); and

(2) an Experimental Data Center (EDC) with the responsibility for receiving the complete assortment of NDC-reported signal data and for deducing epicentral parameters from the reported seismic signals.

The experiment accomplished the three principal objectives for which it was designed. These accomplishments are summarized below.

(1) The signals received at the Center from the five RSTN stations were detected, and measured signal parameters were reported without delay over the Global Telecommunications System of the World Meteorological Organization (WMO/GTS). These operations, which were conducted automatically using pre-established computer algorithms, revealed the convenience and reproducibility of automated analysis. Some deficiencies were revealed, most notably, in the inadequate provisions for extracting the full set of GSE-specified Level 1 signal parameters.

(2) The Center evaluated procedures and the delay times required for signal data to be collected and processed for determining valid epicentral parameters. During the experiment, data from 69 reporting stations were received, the majority of which arrived within three to five days of the seismic occurrence. Many of the events could not be adequately located prior to about 10 to 12 days after their occurrence due to delays in the routine reporting schedules (the reporting stations were not notified of the experiment being conducted at the Center). This element of the experiment also included an evaluation of the WMO/GTS as a means for exchanging seismic data. The limited, but indicative, evaluation documented good performance suited for the needs of the upcoming, large-scale GSE test.

(3) The Center compared two competing programs for the automatic determination of epicentral source parameters from the reported seismic data. Based in part on performance tests obtained during the experiment, it was concluded that the Swedish program could serve as a standard for use in the GSE experiment planned for later in 1984.

The results of the January experiment have been documented in the report:

Results of a Seismic Data Exchange Experiment
27 February, 1984

which was presented by the U.S. Delegation in Geneva at the eighteenth session of the Group of Scientific Experts.

2.1 PLANS FOR A LARGE-SCALE, INTERNATIONAL TEST

In the previously referred meeting in Geneva, plans were made for conducting a large-scale test of procedures for exchanging seismic data in the fall of 1984. Preliminary plans have been made for the Center's participation in this upcoming test and several developmental needs have been identified. The more significant are noted below.

- refinement of algorithms for automatic signal detection and development of algorithms for automatic parameter extraction,
- computer interactive tools for measuring, compiling and validating Level 1 signal parameters,
- parsing software for decoding and storing the complete set of Level 1 signal parameters received from other National Data Centers over the WMO/GTS,
- procedures and communication methods for comparing and refining epicentral parameters to be reported in event bulletins.

While these are probably the major development categories, a number of individual items will require further preparatory work. Preparations for the large-scale test to be held the last quarter of this year comprises the single largest activity at the Center with much of the anticipated development work already underway. A SUN microcomputer has been installed at the Center and is being developed as the primary means for interactively measuring and validating Level 1 seismic parameters and for coding these parameters into WMO messages for reporting over the WMO/GTS. Much of this development work is being performed under a subcontract to Science Horizons, Inc., by the individuals who developed the interactive software that served to demonstrate the viability of the SUN for performing the functions of a Remote Seismic Terminal.

The demo software, developed for an earlier version of the SUN computer, was installed at the Center and used as an interim tool for interactively measuring signal parameters. This system was used to re-examine data recorded on January 19 and 20 for evaluation of automatic detections performed during the January experiment. During the course of this work, several system improvements were identified for installation in the interactive system under development. Work has begun to develop communications links between the SUN computer and the local VAX 11/780 computers. To date, a serial communications link, using TCP/IP protocol, has been established with one VAX (HUGO), and a driver interface has been designed for connecting the SUN to the local Proteon Network, which connects all of the other computers at the Center.

Design specifications have been established by SAI staff members for the development of software for parsing the seismic messages received over the WMO circuits. These specifications are included in Appendix A of this report. Teledyne/Geotech is responsible for the development of the parsing software under the terms of an amended contract. They have been provided copies of the design specifications and the delivery schedule required in order to meet the Center's obligations in the upcoming GSE test.

3. AIDS FOR NEW USERS OF THE CENTER

3.1 DESIGN OF THE HELP SYSTEM

As noted in the technical report for the previous quarter, considerable time and effort is required for new users to become familiar with and learn to operate the computing facilities, the data base access schemes and the application software currently available at the Center. Substantial progress has been made to organize and document the Center capabilities and functions using a computer based help system. When finished, this system will provide visitors and resident staff with ready access to current information on Center capabilities. Accordingly, the help system will provide the means to rapidly disseminate information on relevant acquisitions of new and improved capabilities at the Center. The plan is to provide the user with a facility for contributing comments as a means to maintain current and relevant information in the system.

The general characteristics of the help system under development are described below and the initial hierarchical layout is presented in Appendix B.

Types of help information to be provided with each item:

Description (purpose) of item (executive overview)
How to access item
How to use item (including example of use)

Types of users to access the information:

Visitors and executives to obtain overviews and demos.
Seismologist users to use seismic programs and data.
Programmers and system staff to develop and install programs, and to provide documentation.

Design objectives to the automated help facility:

(1) All documentation, both on and off-line should be referenced in the help facility. Thus, the facility should include a library index. All help texts should reference other relevant help texts and say how to get to them in the menu structure.

(2) All software programs should be able to access their own help text through some interface with the help facility (execl help with the name of the

menu). A default "way back" should be specified for each menu, so if a user gets into a help menu from a program, he can move back up and around the help menu structure in the same way as if he had entered help from unix.

(3) Where it makes sense for the help text for one item to be referenced in more than one help menu, this should be possible. It should also be possible for a help user to access one help menu from more than one other help menu. For example, a help menu on Ingres should be accessible from help menus on databases, as well as help menus on system utilities.

(4) A user should be able to read a particular help text or access a particular help menu if he knows its name. There should be a verbose option to help (-v) which allows the names to appear on the help menus to aid the users in learning the names.

(5) Where the help text for an item is long (more than 1-2 pages) or consists of logical parts (like the arguments to a UNIX command), the user should be able to read the whole help text or just the part he is interested in. When the submenu is into a long text, the "Everything" menu choice should specify how many 24 line pages of text are included. The user should be able to get to the help text on a part via command (help man -k) or through a submenu.

(6) When terminals with graphics and windowing capabilities are made available, help text should appear in a separate window from the one the user is currently working in, and graphics should be included in help text where appropriate.

(7) The help menu structure should mimic the outline of a new document entitled "Guide to the Center for Seismic Studies", and the exact same text that goes into the guide should be accessible from the help menu in pre-nroffed form. Thus, it should be possible to write a program which collects the pieces of text accessible from the help menus and produces the guide automatically.

(8) Where needed, secondary menu structures can be built on top of the primary structure that trace the interests of the executive, seismologist user, or Center programmer/operator staff in their needs for help.

(9) Each help text on a database/text file or program should say how to access the database/text file or run the program. Each help text on an item should include an example, if possible.

(10) The user should be able to concatenate menu choices in response to a menu prompt to bypass intermediate menu display. For instance, 2.3.5 would select the fifth item on the third menu accessible from the menu corresponding to the second item on the current menu.

(11) The user should be given the option to file the current help text he is viewing in a new or old (appended) file or to print the help text.

(12) The following choices should be available to the user at the prompt line for each menu: # or #.#.. to select a menu item, p to go back to previous menu, c to put a copy of the menu in a file or on the system printer, h for help, s to escape to the shell and run a UNIX command, and q to quit help.

(13) Items on a menu which reference text vs another menu should be preceded by a * to differentiate them.

(14) The number of the menu and the menu name should appear above the title. A standard method of abbreviating menu names and help text files should be chosen and adhered to.

(15) There should be an option at the Selection? line to make a comment/suggestion on the current menu display to the help system implementor.

(16) Users should be able to page both forwards and backwards when viewing help text. They should also be able to print the text and store it or append it to a file.

(17) All menus should have an Overview choice which describes briefly the other choices in the menu, suggests an order for reading the items, relates the choices to user tasks, and says who on the Center staff to go to for help. This should be described in the help document on help.

3.2 USER'S GUIDE TO THE CENTER

In contrast to the help system which will contain information on how to use the capabilities at the Center, the User's Guide to the Center will describe the functions and resources. The outline that is being used to develop the User's Guide is presented below.

Executive Summary
of the
Center for Seismic Studies
Outline

1.0 Introduction

2.0 Seismology
2.1 History
2.2 Current Status
2.3 Goals

3.0 Objectives
3.1 Introduction
3.2 The Center as an International Data Center
3.3 The Center as a National Data Center
3.4 The Center as a Seismological Research Center
3.5 History of the Center
3.6 Future Plans of the Center

4.0 Research Activities
4.1 Introduction
4.2 Past Research
4.3 Current and Planned Research
4.4 Visiting Scientists Program
4.5 Experiment Procedures
4.6 Past Experiments
4.7 Current and Planned Experiments

5.0 Facility and System Architecture
5.1 Introduction

5.2 Organization and Staff
5.3 Physical Layout
5.4 System Architecture
5.5 Computer Equipment Descriptions
5.5.1 Introduction
5.5.2 Operational Computer (hugo)
5.5.3 Research Computer (seismo)
5.5.4 Classified Processing Computer (janus)
5.5.5 Communications Interface System (CIS)
5.5.6 Local Network
5.5.7 Peripheral Equipment
5.6 Seismic Analyst Station Description (SAS)
5.7 Remote Seismic Terminal Description (RST)

6.0 Input Data Sources
6.1 Introduction
6.2 Data from Regional Seismic Test Network (RSTN)
6.3 Waveform Data from Global Digital Seismic Network (GDSN)
6.4 Parameter Data from Global Telecommunication System of the World Meteorological Organization (WMO/GTS)
6.5 Parameter Data from National Earthquake Information Service (NEIS)
6.6 Seismic Recording Observatory (SRO) Daytapes
6.7 Digital World-Wide Standardized Seismograph Network (DWWSN) Daytapes
6.8 NORESS Data
6.9 Special Data Sources

7.0 Processing Operational Description
7.1 Introduction
7.2 Input Data Collection
7.3 Automatic Data Processing
7.5 Data Management
7.6 Research and Experiment Support
7.7 Output Data Production
7.8 System Administration

8.0 Output Data Products and Interfaces
8.1 Introduction
8.2 Remote Computer Access
8.3 Database Access Systems
8.4 Special Data Requests
8.5 Group of Scientific Experts Data Exchange
8.6 Publications and Reports

Appendix A: Glossary of Terms

3.3 INTRODUCTION TO INGRES, COMMON DATA REQUESTS

This document helps the new user to the Center for Seismic Studies get started using INGRES databases. After receiving a computer login account, the user should ask for an INGRES account. An INGRES account is obtained according to need from the Database Administrator, Michael Anthony Tiberio (703)

276-7900.

To assist new users of INGRES, a general purpose file, called a "startup file" will be established. This file should be copied into the user's "home directory" by typing the following command:

```
cp  ~dba/DOTINGRES  ~/.ingres
```

This copies the DOTINGRES file from the "dba" home directory to a file called ".ingres" in the users home directory. This file gets executed every time the user invokes INGRES. It establishes default ranges and defines two basic macros. The first one is the "ftyme" macro which is used to decode the epoch time as stored in the databases. The "ftyme" macro should be used as follows:

```
retrieve (o.date,ftyme(o.time),o.lat,o.lon,o.depth)\g
```

to retrieve some basic origin parameters. Of course the "ftyme" macro can be used to decode the time attribute from any relation.

The other macro package is the browse package which has seven self-contained macros useful for viewing several origins, a single origin, a single arrival or a single origin and its several associated arrivals. The macros and their uses are listed below:

work event 1234\g

> This macro will establish event 1234 as a reference event. The current origin for this event becomes the working origin.

work origin 4321\g

> This macro will establish origin 4321 as a reference origin and will automaticly make the corresponding event the working event.

pr event\g

> This macro will print the origin parameters and the associated arrival information for the current origin for the current event.

pr origin 4321\g

> This macro will print the origin parameters and the associated arrival information for the origin pointed to by the given origin identifier (4321).

pr arrival 777\g

> This macro will retrieve arrival parameters for the arrival with the arrival identifier (777).

sumev\g

> This macro will print information about the current event. This information will consist of what the current event identifier is and what the preferred and current origins are that are pointed to by this event.

listev\g

This macro will list in time sequence some commonly desired origin parameters for all the origins in the database.

The numbers given above are for demonstration purposes; any vaid id, (evid, orid, arid) can be used. If one would like to see what the macro expands to before executing the data request, the following command sequence should be followed:

```
pr origin 1234
\eval
\p
```

This will expand the macro "pr origin" and replace the contents of the INGRES query buffer with the expanded version. In this way the user can edit the buffer if desired, allowing greater flexibility of what would otherwise be a hard coded query.

Below are 14 common seismological queries in both their English and query language (QUEL) form. There is also some information on how the query works. Feel free to use these queries and to modify them to fit individual needs.

Query 1:

List all origins in the Eastern Kazakh region.

```
range of o is origin
retrieve (o.date,ftyme(o.time),o.lat,o.lon,o.mb,o.ms,o.orid)
where o.grn=329
```

This query works because Geographic Region 329 is the region number for Eastern Kazakh. A commonly desired subset of the available origin attributes is retrieved, however an alternate set (or all) could be retrieved by modifying terms contained in the second command line.

Query 2:

List all the available information on the event with the largest mb from Eastern Kazakh.

```
range of o is origin
retrieve (o.all) where o.mb=max(o.mb where o.grn=329)
```

This query uses what is called an aggregate function (max). These functions are allowed to have their own "where" clause. Caution is advised when using these functions, because the use of cascading logic sometimes produces results dramatically different from what is intended.

Query 3:

Provide the list of waveforms that are on disk and available for the event retrieved above.

```
range of a is arrival
range of z is assoc
range of w is wfdisc
retrieve (w.date,ftyme(w.time),w.sta,w.nsamp,w.dir,w.file,w.foff)
where and w.wfid=a.wfid and a.arid=z.arid and z.orid=1234
```

This query uses the "orid" as returned by query 2 (1234). It takes advantage of the fact that arrivals from digital stations have the same "wfid" as the waveform that generated them. This may not be the case when arrivals and waveforms are provided to the Center by different organizations. In that special case where the "wfid" cannot be trusted, the following query will work, and as such, this is the more general query, albeit slower.

```
range of a is arrival
range of z is assoc
range of w is wfdisc
retrieve (w.date,ftyme(w.time),w.sta,w.nsamp,w.dir,w.file,w.foff)
where z.orid=1234 and z.arid=a.arid and a.sta=w.sta and a.chan=w.chan and
a.time>w.time and a.time<w.time+(w.nsamp-1)/w.smprat
```

This query works because station, channel and time are the three attributes necessary to characterize a waveform. This query checks to make sure but the arrival falls within the start and end of the waveform and checks to make sure that the station and channel agree.

Query 4:

Provide a list of readily available waveforms recorded at a particular station, CHTO, for events in Eastern Kazakh.

```
range of a is arrival
range of z is assoc
range of w is wfdisc
retrieve (w.all) where o.grn=329 and o.orid=z.orid and z.arid=a.arid and
a.wfid=w.wfid and w.sta="CHTO"
```

Once again this query uses the "wfid" as a link between the "arrival" relation and the "wfdisc" relation. If one wishes a more extensive waveform search the "wftape" relation should be searched.

Query 5:

List all events 60 to 70 degrees from station ANMO with event to station azimuths between 25 to 35 degrees.

```
range of o is origin
range of z is assoc
range of a is arrival
retrieve (o.all) where a.sta="ANMO" and a.arid=z.arid and
z.delta>60 and z.delta<70 and z.esaz>25 and z.esaz<35 and
z.orid=o.orid
```

This query takes advantage of two attributes of the "assoc" relation: delta and esaz. This query joins three relations and would likely run quite slowly on a large database.

Query 6:

List all events which have more than 100 associated arrivals

```
range of o is origin
```

```
range of z is assoc
retrieve (o.all)
where o.orid=z.orid and count(z.arid by z.orid)>100
```

This query uses the count aggregate function. Besides "where" clauses these functions are allowed to have "by" clauses. Once again care must be utilized when using such functions as one could develop a query that could take days to complete.

Query 7:

List the origin ids, the number of associated arrivals and the associated arrivals from digital stations for all events.

```
range of o is origin
range of z is assoc
retrieve (o.orid,acount=count(z.arid by z.orid),
dcount=count(z.arid by z.orid where z.arid=a.arid and a.dig="+"))
```

This query uses both a "by" and a "where" clause in the "dcount=count" aggregate function. This query also takes advantage of the dig(ital) attribute of the arrival relation, which is set to "+" when the arrival comes from a digital station (this in no way assumes that the waveforms are on line).

Query 8:

For a given range of latitudes and longitudes retrieve all the origin ids.

```
range of o is origin
retrieve (o.orid) where o.lat>10 and o.lat<20 and o.lon>50 and o.lon<60
```

This query is a simple variant of Query 1.

Query 9:

For all events with depths in the range 500-600km and more than 50 reporting arrivals, list all the origin attributes. Using that list print all the arrival ids and their residuals.

```
range of o is origin
range of z is assoc
retrieve into deep (o.all) where o.depth>500 and o.depth<600 and
count(z.arid by z.orid)>50 and z.orid=o.orid
print deep
range of d is deep
retrieve (z orid,z.arid,z.resid) where z.orid=d.orid
```

This query uses a temporary relation (deep) to store an intermediate result. These relations are useful when the output of one query is important enough to save for future use, or when the query takes long enough to run and that it would not be practical to run it again.

Query 10:

List all arrivals for which the phase is Pn and waveform data are likely to be available.

```
retrieve (a.all) where a.phase="Pn" and a.dig="+"
```

If absolute knowledge about available waveforms were desired, then this query should be linked to the "wfdisc" and "wftape" relations.

Query 11:

List all arrivals and their residuals for phases P and Pn in the distance range 20 to 25 degrees for region 329.

```
range of z is assoc
range of a is arrival
range of o is origin
retrieve (a.all,z.resid)
where a.phase="P" or a.phase="Pn"
and z.delta>20 and z.delta<25
and o.grn=329 and o.orid=z.orid and z.arid=a.arid
```

This query uses a three way join of relations, and caution is suggested when formulating such queries.

Query 12:

List all possible explosions (shallow events) for which depth and Ms has been reported.

```
range of o is origin
retrieve (o.all) where o.depth<5 and o.ms>0
```

This query lists possible explosions, if one wanted to be sure, on could go to the EXPLOSION database or link this query with the "explo" relation.

Query 13:

List waveform indices for stations which have at least one hour of continuous 3 component short period data.

```
range of w is wfdisc
retrieve (w.all) where
count(w.chan by w.time where
w.chan="s*" and (w.nsamp-1)/w.smprat >= 60*60) > 3
```

This query takes advantage of the fact that three component data from a given station has the same start time across each response band.

Query 14:

List all events for a given time period and indicate whether or not there is any data for station ANMO for each event.

```
range of a is arrival
range of z is assoc
range of o is origin
```

```
retrieve
(o.all,numanmo=count(a.arid by z.orid where a.arid=z.arid and a.sta="ANMO"))
where o.orid=z.orid and o.date>1980276 and o.date<1980286
```

This query uses a range of dates to cut down on the number of possible tuples that satisfy it. This is a common technique for speeding up queries.

3.4 DATA CONVERSION GUIDE

All of the various components of the "dbsubs" database subroutine package developed at Lincoln Laboratories are now referred to as Version 1.0. Version 2.6 represents the sixth iteration of what has been a serious attempt to take everything we learned using Version 1.0 and design a new seismic database system. Our database system has always been relational, meaning that it is based on flat, two dimensional tables. The basic kinds of tables (or files) required to represent seismic data is unchanged, only the number of attributes (columns) and their units have been changed. A comprehensive set of null values has been defined, adding a second dimension to the database, the knowledge of non-existent data. This document guides the casual user in the conversion of their existing Version 1.0 program to Version 2.6. Only the most important conversions are covered here. Other new to old mappings of relations not covered here are: feature relation <=> rags relation, gregion relation <=> regions relation, station relation <=> stations relation, counter relation <=> counters relations, and event relation <=> events relation.

Version 2.6 <=> Version 1.0

arrival relation (db.arrival file) <=> arrivals relation (db.a file)

date	<=>	date	date now has century (1980276 <=> 80276)
time	<=>	time	time now uses 1970001:0:0:0 as datum
sta	<=>	sta	length increased to allow for longer names
chan	<=>	chan	
dig	<=>	?	
qual	<=>	qual	
phase	<=>	phase	length increased to allow for longer names
fm	<=>	fm	
amp	<=>	amp	
per	<=>	per	
logat	<=>	?	
coda	<=>	coda	
seaz	<=>	azimuth	
slow	<=>	slow	
ema	<=>	?	
dist	<=>	distance	
stype	<=>	drange	more possible values increase utility
clip	<=>	?	
arid	<=>	arid	
ftid	<=>	rag	
chid	<=>	?	
wfid	<=>	?	
auth	<=>	auth	
remark	<=>	?	

assoc relation (db.assoc file) <=> oax relation (db.x file)

arid <=> arid
orid <=> orid
delta <=> delta
phase <=> phase
esaz <=> azimuth
seaz <=> ?
resid <=> resid
atype <=> atype
wgt <=> wgt
mag <=> mag
tratbl <=> ?
remark <=> ?

origin relation (db.origin file) <=> origins relation (db.o file)
date <=> date
time <=> time
lat <=> lat
lon <=> lon
depth <=> depth
mb <=> mb
ms <=> ms
mo <=> ?
maxint <=> ?
nass <=> ?
ndef <=> ndef
ndp <=> ?
nmb <=> ?
nms <=> ?
depdp <=> ?
orid <=> orid
evid <=> evid
grn <=> region
srn <=> ?
ltype <=> ?
dtype <=> ?
etype <=> ?
auth <=> auth
moauth <=> ?
intscl <=> ?
remark <=> comm

wfdisc relation (db.wfdisc file) <=> gid relation (db.gi file)
date <=> year,mon,day
time <=> year,mon,day,h,m,s
sta <=> sta
chan <=> resp,orient   chan is first two chars of insttype
nsamp <=> nsamp
smprat <=> inter   sample rate = 1.0/sample interval
calib <=> calib
calper <=> ?
instyp <=> insttype
segtype <=> ?
dattyp <=> type   type was stored in db # g file 12 byte header
clip <=> ?
chid <=> ?

wfid <=> ?
dir <=> dir   dir not in all Version 1.0 gi files
file <=> file
foff <=> ?
adate <=> ?
remark <=> comment

db.#.w file <=> db.#.g file
variable offsets to data <=> 12 byte offset to data
more than one waveform per file <=> one waveform per file

The <=> symbol implies that the new attribute hold the same type of data as the old one(s). Most attributes map cleanly to the new ones. Some like smprat<=>inter are the inverse of one another. Date, time replace 6 attributes (year,mon,day,h,m,s) in the old gi relation/file. There are of course some attributes in Version 1.0 that do not map at all into Version 2.6, these were deemed unnecessary and eliminated. Some of the Version 1.0 origins attributes did not find their way into the Version 2.6 origin relation because we made a new relation, "origerr" to hold these. We will not attempt in this document to relay all the nuances of converting those attributes that are not the same in both versions. The reader should refer to two documents which give descriptions of each database version in detail. Those documents are, for a Version 1.0 database description:

Documentation for a Prototype Seismic Data Center, Lincoln Manual 132

For a description of Version 2.6 of the database:

Center for Seismic Studies: Prototype Design and Development
S-Cubed Final Report, Task IV, Volume 1

Both of these documents are available at the Center and the user is encouraged to seek them out. The user level subroutines that take the place of the old dbsubs package is now available. In order to link to the package one must put -lextf (for external file) on the compile line. Documentation for this package is available in Appendix 12 of Volume 2 of the S-Cubed report mentioned above.

4. DATA BASE DEVELOPMENT

4.1 WORLD I DATA BASE

The map data base for the whole world has been obtained at the Center for Seismic Studies and is now available for general use. The World I data base contains about 110 thousand points in 1244 individual curves where a curve is defined as a set of latitude, longitude points for which the plotter pen is to stay down during drawing. The data base and associated index file are located on HUGO in the directory called: /ee/maps/worldI. The data file is called: worldI.dat and the index file is called: worldI.ind. The data file is a direct access binary floating point file with the record size of eight bytes, four bytes for the latitude and four bytes for the longitude.

The index file is human readable and can also be read by the computer with the following FORTRAN format:

(1x,i4,2i7,i5,4f10.4,1x,a2,1x,a2)

where the entries have the following meaning:

(1) index file sequence number (1 through 1244),

(2) a 6-digit curve sequence number identifying the curve in an arbitrary manner; this number is not very useful except for the first digit which roughly corresponds to continental divisions in the following order: 1 - North America, 2 - South America, 3 - Europe, 4 - Africa, 5 - Asia, 6 - Australia and surrounding area, 7 - Antarctica,

(3) record number pointer to the data file (note that byte record seeks must multiply this number by eight),

(4) the number of latitude, longitude pairs for this curve; this number varies between a few to more than 2000,

(5) through (8) the minimum and maximum latitude and longitude values which describe the corners of the box containing the curve, the order is: min-lat, min-lon, max-lat, max-lon. These values are useful for a program to determine if a candidate curve belongs to a current picture and perhaps avoid reading the data file. and (10) the two-character country code for each side of the curve; the code equivalents are contained in a file called: country.codes in alphabetical code order. If one or the other of these two fields is blank then one side of the curve borders an ocean.

By way of example, the following table represents the first four and the last four entries of the contents of the index file:

INX	SEQ	REC. NO.	NO. PTS	MIN-LAT	MIN-LON	MAX-LAT	MAX-LON	CC	CC
1	100001	1	8	63.0049	-164.7049	63.0499	-164.3298	US	
2	100002	9	353	62.9999	-168.1347	68.8783	-159.5215		US
3	100003	362	320	68.8466	-166.2709	71.3409	-141.0188		US
4	100004	682	372	68.5549	-141.0188	70.5402	-116.9848		CA
1241	700081	109777	12	-73.5094	-104.9056	-73.2462	-104.1597	AY	
1242	700082	109789	12	-69.0740	-90.9216	-68.7930	-90.3547	AY	
1243	700083	109801	480	-75.1433	-135.3154	-63.3443	-56.9340		AY
1244	700085	110281	7	-64.6364	-57.5344	-64.4534	-56.9499	AY	

The data values are floating point decimal degrees and fractions thereof with south latitudes and west longitudes being negative. The accuracy of the data values is four places to the right of the decimal which, theoretically, can represent very good accuracy but the advertized resolution is about five miles.

Routines for manipulating the raw data are being developed and they will be documented as they emerge.

4.2 NORSAR DATA BASE

The NORSAR database contains 40 hertz sampled short period vertical waveforms from the 21 element NORSAR array for eight selected events in 1983.

A program was written to read the experimental data tape, and is described in another document. Event information was input by hand and loaded into the database. Below are listings of the available events and waveforms available. Since each element of the array was segmented identically, we have provided the listing for the NOR1 element to save space. Waveforms covering the same time period are available for all the other elements. First the event list:

LAT	LON	DATE	TIME	DEPTH	GRN	COMMENTS
63.89	17.53	Sep 29.1983272	05:03:22.720	10.80	536	channels 17-21 out
59.74	13.25	Oct 3.1983276	09:50:40.680	5.00	536	location accurate to 1 km
59.74	10.79	Oct 11.1983284	14:30:36 000	0.00	535	mine blast exact location
59.31	6.93	Oct 21.1983294	12:11:00.000	0.00	535	mine blast
60.26	5.20	Nov 1.1983305	10:35:00.000	0.24	535	under water explosion
60.38	5.34	Nov 1.1983305	12:20:00.000	0.00	535	15*10kgs chem explosion
60.04	4.52	Nov 1.1983305	12:43:00.000	0.30	535	under water explosion
50.72	5.35	Nov 8.1983312	00:49:32.000	10.00	541	natural event 64 stations

Some of the origins are known to quite an extreme precision as they are chemical explosions. All of the events are within 11 degrees of the NORSAR array. Below is the listing of the available waveform segments:

STA	CH	DATE	START_TIME	END_TIME	LENGTH
NOR1	sz	1983272	05:02:00.000	05:08:10.000	370.0
NOR1	sz	1983276	09:49:00.000	09:54:10.000	310.0
NOR1	sz	1983284	14:28:00.000	14:32:10.000	250.0
NOR1	sz	1983294	12:09:00.000	12:15:10.000	370.0
NOR1	sz	1983305	10:34:00.000	10:39:10.000	310.0
NOR1	sz	1983305	12:19:00.000	12:50:10.000	1870.0
NOR1	sz	1983312	00:50:00.000	00:58:10.000	490.0

Limited station parameters are available in the station relation. Below is a table showing the relevant attributes.

STA	LAT	LON	ELEV	GRN	SNAME
NOR1	60.7352	11.5414	306.0	535	NORESS_A0
NOR2	60.7365	11.5415	291.0	535	NORESS_A1
NOR3	60.7347	11.5425	307.0	535	NORESS_A2
NOR4	60.7347	11.5400	298.0	535	NORESS_A3
NOR5	60.7377	11.5420	303.0	535	NORESS_B1
NOR6	60.7351	11.5442	317.0	535	NORESS_B2
NOR7	60.7331	11.5432	321.0	535	NORESS_B3
NOR8	60.7331	11.5397	305.0	535	NORESS_B4
NOR9	60.7364	11.5390	293.0	535	NORESS_B5
NO10	60.7415	11.5420	316.0	535	NORESS_C1
NO11	60.7384	11.5470	346.0	535	NORESS_C2
NO12	60.7333	11.5473	362.0	535	NORESS_C3
NO13	60.7292	11.5431	313.0	535	NORESS_C4
NO14	60.7297	11.5380	302.0	535	NORESS_C5
NO15	60.7346	11.5344	316.0	535	NORESS_C6
NO16	60.7403	11.5373	280.0	535	NORESS_C7
NO17	60.7485	11.5428	312.0	535	NORESS_D1
NO18	60.7450	11.5510	374.0	535	NORESS_D2
NO19	60.7267	11.5523	387.0	535	NORESS_D4
NO20	60.7220	11.5449	351.0	535	NORESS_D5
NO21	60.7288	11.5292	338.0	535	NORESS_D7

5. ON-LINE SYSTEM REFINEMENTS

5.1 RDSCARS - PROGRAM TO READ SCARS FORMATTED TAPES

RDSCARS is a program to read SCARS tapes, implemented in the 'C' programming language under the UNIX(tm) environment at the Center for Seismic Studies. Rdscars, and the program it invokes, scarstodb, work together to give a flexible fast conversion of SCARS format data to a Center database Version 2.6 database. Rdscars reads the tape device and demultiplexes the data down to the station level. Rdscars then feeds (in the case of present RSTN configuration) 5 copies of the scarstodb program one each of the 5 RSTN stations data. Each copy of scarstodb invoked demultiplexes the stations data down to the individual channel level. This two stage processing has two advantages. First attempting to open and close the 45 waveform files (5 stations times 9 channels) from within one program would be prohibitively slow under UNIX (UNIX allows at most 30 open files). Previous experience with the Rdgdsn program showed us that a great deal of time can be spent simply opening and closing said files. With the present configuration each scarstodb child can keep all the waveform files that it needs open all the time and this greatly speeds up the throughput. The second advantage from this two stage processing is that in the future when the number of NSS stations increases, the programs will require little or no modifications to handle it.

Rdscars has a number of useful options including some to read just a desired subset of the available data (either by time, station or record number) and options that produce detailed listings of the file header information. Rdscars reads files from the tape, swaps the bytes and the decides from the information in the header if this data is part of the desirable subset and which scarstodb child to pipe it to. This is done until the end of the tape is reached. Scarstodb reads data from its pipe and based on information in the record headers it might stub the presently open waveform and start another. In either case scarstodb degainranges the data, converting it to 32 bit long integers and writes it out to the waveform file. There are a number of reasons why scarstodb might deem it necessary to start a new waveform segment. One is that out of sequence data has been read (scarstodb does not zero fill gaps) the second is that SCARS has switched the KS-36000 spz seismometer for the S-750. The different seismometers have different instrument responses thus not marking the changeover point would compromise the data quality for those interested in instrument corrected waveforms. Scarstodb also keeps track of calibration pulse indicators and clipped data indicators. Presently the greatest loss of data is due to data frames coming through with bad time stamps. Scarstodb will not start a waveform with a data frame that has a bad time stamp (certain bits in the header indicate the quality of the time stamp). This is crucial because digital data quality depends so heavily on the start time and sample rate of the waveform segment. To this end, Scarstodb calculates the actual sample rate rather than assume the nominal rate.

Output of the Rdscars/Scarstodb process is a suite of files sometimes referred to as an external file database. It is named so due to the fact that it is external to INGRES. For each station on the tape, there exists one .wfdisc file (actually dbprefix.wfdisc) and nine .w files (actually dbprefix.[1-9].w. There is one waveform file for each channel, however Version 2.6 of the database has provisions for indexing more than one waveform segment in a given file, using file offset in bytes. Thus, if for some reason the waveforms on the tape do not span one contiguous segment scarstodb will generate multiple records in the wfdisc file pointing to the segments. Dbprefix is a concatenation of the database prefix passed Rdscars plus the station number, thus if 'rstn' is passed to Rdscars as a database prefix, the result will be 5 external file databases with prefixes like rstn1, rstn2, rstn3, rstn4, rstn5. This scheme is necessary to insure there will be no conflict in the file names. Once dumped to disc an external file database can be used as is by any number of Center supported programs or accessed by user programs via the libextf subroutine library. Waveforms themselves are never loaded into INGRES databases. The contents of the wfdisc files can be if desired. At that point the installation of the data is done.

5.2 RDNRS - PROGRAM TO READ NORSAR DATA TAPES

Rdnrs is a program to read temporary NORESS data tapes. These tapes are a preliminary version of what will no doubt be a more complicated tape format in the future. These NORESS tapes are blocked at 22560 bytes per block. Record size within each block runs 1128 bytes. Each record has an 8 byte header of which the first 4 bytes are, as an integer, the number of deci-seconds into the year. The tape gives no indication of what year the data is from so the program is hard coded to assume 1983, since all the tapes we have are from that year. The header is followed by 560 short integers, which contain the 28 channels (2: are actually used) of multiplexed NORESS data. The data must be byte swapped once read from tape and additionally the time must be word swapped in order to get it into VAX long integer format. The short 16 bit integers are promoted to 32 bit integers which is the Center standard. Any time the program runs across a time stamp that doesn't follow by 1/2 second the previous time stamp (there is 1/2 seconds worth of data per record), the program stubs the waveform segments (essentially writes out the wfdisc records for those waveforms) and starts a new set. The multiple waveform per file provision of Version 2.6 of the database is used to keep the number of waveform files down. There is a minimum of 28 .w files and one .wfdisc file generated by an invocation of Rdnrs. The waveform data is sampled at 40 hertz and the sensor is oriented vertically.

5.3 COMPARISON OF SCARS AND CENTER BACKUP TAPES

As part of an ongoing data quality assurance program SCARS data from both Sandia generated SCARS tapes and Center generated SCARS tapes were compared for both differences in outages and differences in the waveforms themselves. This is a preliminary report on the findings so far. At the Center for Seismic Studies software has been developed recently to read SCARS tapes directly into the VAX computer. This software was modified to produce verbose output and a detailed log of every break in the data and every block of data thrown out. SCARS data comes in approximately one second packages. Each package has a header that contains three important values necessary for the reconstitution of the original continuous waveform. These values are the time stamp, basically the time at the beginning of the frame of data; the time stamp authentication bits, an indicator of the quality of the time stamp; and the sequence number, basicly a monotonicly increasing unsigned integer stamp put on the data at the digitizer. In order to begin a waveform segment the program insists that a frame with a good time stamp be found. In order for data to be appended to a given waveform the program insists that its sequence number follow the previous sequence number. If an out of order sequence number is found, the program starts a new waveform, and the program once again searches for a frame with a good time stamp. It is necessary to keep this in mind when interpreting the results.

Two scars tapes recorded by the Center and two recorded at Sandia were read. Tapes from January 5th 1984 were selected because they were recently written. At the frame level we can expect the data to be the same since it all comes from the same stations. However the individual start times of the tapes are a function of the operation schedules of each organization. Thus we can only compare the overlapping times for each set of tapes shown below. The library numbers shown for the Sandia tapes are the numbers used to file them in the Geotech Alexandria tape library, our source of Sandia tapes.

	Center	SANDIA
tape:	06075	R4310
start:	07:04:24	09:53:10
end:	13:44:24	15:45:30
tape:	06076	R4311
start:	13:44:24	15:45:30
end:	20:24:44	21:33:10

Thus we can use the time period 09:53:10 to 20:24:44 for comparison. Since each of the stations is processed in parallel and since the output is quite verbose, we will report the results for station RSNY sz. It is typical of the entire network, and the results are qualitatively similar to comparisons between Sandia and Center tapes on other dates.

The sz channels of these tapes were analyzed for missing or unusable (about 1 second each) by checking times and sequence numbers of successive frames, and by checking the time stamp authentication bits. The results of the analysis were:

(1) *SANDIA* tapes: The SCARS tapes contained 42,000 usable frames, with no missing frames and all with authenticated time stamps. The data were suitable for forming a perfect, continuous archive.

(2) Center tapes: The Center's tapes for the same 42,000 seconds contained 65 unusable frames. These caused the archived records to be broken into eight separate record segments, each separated by gaps in the data. The major problem appeared to be associated with the section of retransmitted (delayed) data onto the tape to replace data blocks missed from the primary transmission. All of these inserted blocks failed to authenticate (time stamp), and in each case a number of the following data blocks being recorded from the primary transmission also failed to authenticate. The result was that the insertion logic failed to correct the initial problem, and created a new and larger set of unusable blocks.

While the amount of unusable data on the Center's tapes is a relatively small percentage of the total data, the Sandia experience shows that it is unnecessary and results from faulty programming. Furthermore, interruptions in the data create inefficiencies in the Center's archives; each interruption is treated as the completion of a waveform, leaving the remainder of the archive record to be filled with zeros. The following segment starts a new record, which may or may not be filled, depending on the length of the segment. Interruptions also cause problems in various programs that use the data, e.g., the detection processor "reinitializes" and has a warm-up time prior to convergence on a stable noise estimate for the new waveform segment.

APPENDIX A. DESIGN NOTES FOR A PARSER OF WMO MESSAGES

The preparation requirements for the seismic messages that come into the Center over the WMO and other sources are well defined in various reports published by the GSE. Unfortunately, not all seismic stations comply with that format and furthermore, transcription and transmission errors cause imperfect messages. Experience by seismic analysts who deal with this type of data indicate that there are certain categories of deviations that can be identified and classified to the extent that is helpful for inclusion into the parser program.

The first basic responsibility of the parser is to take in an alphanumeric string of data, identify the individual elements that comprise the seismic message, equate the data elements with slots in the target data base and format the output to conform to data base loading. As much as possible, the parser should be general enough to admit changes in input or output detail. That entails that the collection of input and output elements can be specified in the form of tables and that the contents of the tables can be modified but the program itself can remain constant.

The second task of the parser is to perform certain data conversions (e.g.: amplitude corrections or conversion). These can also be provided in the form of tables.

The third task relates to the validation and verification of the actual data values. This process is difficult to force into table driven mode because it could involve exact string matching (e.g.: station name), date and time checking, acceptable range values (e.g.: latitude/longitude values), etc. Thus, some combination of subroutines and tables will be necessary to solve this problem which, at least in the short term, will be a moving target.

The basic operational sequence of the parser can be described as follows. Inspect an input element and examine in the context of expected information. If it passes then convert it into the proper internal form (e.g.: floating point word), perform the indicated conversion if necessary and pass it on for validation. If no errors occur then the data element can be put into the output record structure, otherwise, an error indication is generated with some feedback as to the nature of the error. The parser can then perform the same operation on subsequent elements. Some of the errors are fatal and cause no records to be output whereas some other errors simply cause certain record elements to be missing in the output. The analyst can look at the errors and correct the original input data by editing and pass the alphanumeric corrected file back to the parser.

With this background, some of the details for the parser program can be specified. The parser will be driven by a linked four-level set of files. The first file is a "source" file which contains a mnemonic list of data sources: WMO yyddd (where yy is the last two digits of the year and ddd represents the day of the year), NEIS, UK, CAN, YKA. Corresponding entries will point to files which contain a list of acceptable network names and the contents of the message must match one of these entries (e.g.: JPSD20). This is only applicable to WMO networks at present since the single source entries (e.g.: NEIS) have a rather predictable format. Entries in this network name files will point to files containing a list of stations and their defining characteristics (e.g.: latitude, longitude). This step helps to verify the station list which does not change on a daily basis and which must be maintained at the Center. Entries in the station file will point to station characteristics files where the "peculiarities" related to individual stations can be entered. Examples of these may be a list of acceptable phase names, the units in which a station normally presents amplitude measurements, correction factors to be applied to amplitude or period.

The following is an example of a somewhat idealized WMO message. Note that the body of the message is delimited by the code word "SEISMO" at the start and the word "STOP" at the end. After the station code and date, the primary phase followed by the secondaries is reported. The primary phase measurements are: the name of the phase (a list of these will be in an external file as described above), time, amplitude and period. Amplitude is preceded by the letter "A" and the period by the letter "T". Amplitude and period can occur in either order. Information about array stations deviates from this form by the appearance of slowness, azimuth, latitude, longitude, etc.

```
01   SEISMO N82351((BEG SEP22 180000 END SEP23 240000 NM8))

02   ARR SEP22

03   IPCU 1919020
04                      M1X19035 T3A60
05                      M2X19112 T3.2 A53.1
06                      M3X19160 T3.5A29.8
07                      M4X19233 T3.5 A27.2
08                      MLP19060 T6A144
09                      NT1.0 NA5.1
10                      NLPT8 NLPA15

11   E PP 2247 T3.6A18.2
12                      T8 A108

13   ES 30025
14                      MSE 30080 T4A75.2
15                      MSN 30080 T4A61.0
16                      MSLPE 30090 T9A216
17                      MSLPN 30090 T9A135

18   ESS 3711 T4.7A61.7
19                      T12 A192

20   LRZ 4841
21                      MLR5407 T22A271
22                      M1L5637 T10A135
23                      M2L5311 T20A200
24                      M3L5203 T30A105
25                      M4L5012 T40A98
26                      NLPT20 NLPA12

27   LQ 4251
28                      MLQE4302 T21A220
29                      MLQN4302 T21A172

30   CMPX 23.02 SPMM 2.45

31   SLO 4.8 AZ226 DIS94

32   LAT-35 LON-120 OT190541 MB6.5

33   SLOLP 4.8 AZLP221

34   MS6.4 MSH6.6

35   ARR
36   S 2358100
37                      MSE 58162 T2.8 A46.7
38                      MSE 58162 T2.7 A53.2

39   STOP
```

The following is a list of possible reported phases and their relationship to the Center data bases. The only relations that are affected by parameter data are: arrival (a), origin (o) and feature (f). It is possible that the "extra" relation will be affected if the comment section overflows the comment field of the arrival relation (all fields in the message delimited by double parentheses are considered as comment).

SPZ PRIMARY:			
qual	I,E,()	onset clarity	a.qual
phase	P,PKP,PN,PG,PB	primary phase	a.phase
fm	C,D,R,U	first motion	a.fm
time	hhmmss.s	time	a.time
phase	M1X	0-6 sec	a.phase
time			a.time
amp	Axxx.x		a.amp
per	Txx.x		a.per
phase	M2X	6-12 sec	a.phase
time			a.time
amp			a.amp
per			a.per
phase	M3X	12-18 sec	a.phase
time			a.time
amp			a.amp
per			a.per
phase	M4X	18-300 sec	a.phase
time			a.time
amp			a.amp
per			a.per
amp	NAx.x	noise amp	a.amp
per	NPx.x	noise period	a.per
SPZ SECONDARY:			
qual			a.qual
phase	PP,PPP,etc.		a.phase
time			a.time
amp			a.amp
per			a.per
SPH SHEAR:			
qual			a.qual
phase	S		a.phase
time			a.time
phase	MSN	S max on SP N-S	a.phase
time			a.time
amp			a.amp
per			a.per

phase	MSE	S max on SP E-W	a.phase
time			a.time
amp			a.amp
per			a.per
SPH SECONDARY:			
qual			a.qual
phase	SS,SSS,etc.		a.phase
time			a.time
amp			a.amp
per			a.per
LPZ PRIMARY:			
qual			a.qual
phase	P or primary		a.phase
fm			a.fm
time			a.time
phase	MLP	P max on LP Z	a.phase
time			a.time
amp			a.amp
per			a.per
phase	LR	Rayleigh wave	a.phase
time			a.time
phase	MLRZ	LR max on LP Z	a.phase
time			a.time
amp			a.amp
per			a.per
phase	M1L	10 second LR	a.phase
time			a.time
amp			a.amp
per			a.per
phase	M2L	20 second LR	a.phase
time			a.time
amp			a.amp
per			a.per
phase	M3L	30 second LR	a.phase
time			a.time
amp			a.amp
per			a.per
phase	M4L	40 second LR	a.phase
time			a.time
amp			a.amp
per			a.per
amp	NLPAxxx	noise amp LP Z	a.amp
per	NLPTxx	noise period LP Z	a.per

LPZ SECONDARY:

phase	PP,PPP,etc.		a.phase
time			a.time
amp			a.amp
per			a.per
LPH SHEAR:			
qual			a.qual
phase	S		a.phase
time			a.time
phase	MSLPN	S max on LP N-S	a.phase
time			a.time
amp			a.amp
per			a.per
phase	MSLPE	S max on LP E-W	a.phase
time			a.time
amp			a.amp
per			a.per
phase	LQ	Love wave	a.phase
time			a.time
phase	MLQN	LQ max on LP N-S	a.phase
time			a.time
amp			a.amp
per			a.per
phase	MLQE	LQ max on LP E-W	a.phase
time			a.time
amp			a.amp
per			a.per
LPH SECONDARY:			
phase	SS,SSS,etc		a.phase
time			a.time
amp			a.amp
per			a.per
ARRAY:			
slow	SLOx.x	slowness	a.slow
seaz	AZxxx	azimuth	a.seaz
dist	DISxx	distance	a.dist
slow	SLOLPx.x	slowness from LP	a.slow
seaz	AZLPxxx	azimuth from LP	a.seaz
lat	LATxx.x	latitude	o.lat
lon	LONxxx.x	longitude	o.lon
time	OThhmmss.s	origin time	o.time
mb	MBx.x	mb	o.mb
ms	MSx.x	Ms	o.ms
mo	MSHx.x	mag from S on LP H	o.mo
ADDITIONAL:			
cmpx	CMPXxx.xx	complexity	f.cmpx

spmm	SPMMx.xx	spectral moment	f.spmm
sprt	SPRTx.xx	spectral ratio	f.sprt
spvt	SPVTx.xx	spectral vector	f.spvt
tmfi	TMFIx.xx	3rd Mom Freq Init	f.tmfi
tmfc	TMFCx.xx	3rd Mom Freq Coda	f.tmfc

Finally, the following example details how the above presented example would be parsed in detail and it shows where in the data base each of the data elements belong.

01	open db.arrival, db feature, db.origin establish year=1978 establish author="wmo:N82351"		
02	establish sta="ARR" establish date=1978265		
03	append arrival	arid=1	ftid=1 qual="i" phase="P" fm="cu" time=191902.0 date=1978265 sta="ARR" chan="sz" author="wmo:N8235
04	append arrival	arid=2	ftid=1 phase="M1X" time=191903.5 amp=60.0 per=3.0 date=1978265 sta="ARR" chan="sz" author="wmo:N8235
	replace arrival	arid=1	amp=60.0 per=3.0
05	append arrival	arid=3	ftid=1 phase="M2X" time=191911.2 amp=53.1 per=3.2 date=1978265 sta="ARR" chan="sz" author="wmo:N8235

06	append arrival	arid=4	ftid=1 phase="M3X" time=191916.0 amp=29.8 per=3.5 date=1978265 sta="ARR" chan="sz" author="wmo:N8235
07	append arrival	arid=5	ftid=1 phase="M4X" time=191923.3 amp=27.2 per=3.5 date=1978265 sta="ARR" chan="sz" author="wmo:N8235
08	append arrival	arid=6	ftid=1 phase="MLP" time=191906.0 amp=144.0 per=6.0 date=1978265 sta="ARR" chan="lz" author="wmo:N8235
09	append arrival	arid=7	ftid=1 phase="NOISE" time=191832.0 amp=5.1 per=1.0 date=1978265 sta="ARR" chan="sz" author="wmo:N8235
10	append arrival	arid=8	ftid=1 phase="NOISE" time=191802.0 amp=15.0 per=8.0 date=1978265 sta="ARR" chan="lz" author="wmo:N8235

11	append arrival	arid=9	ftid=1 qual="e" phase="PP" time=192247.0 amp=18.2 per=3.6 date=1978265 sta="ARR" author="wmo:N8235
12	append arrival	arid=10	ftid=1 phase="PP" time=192247.0 amp=108.0 per=8.0 date=1978265 sta="ARR" chan="lz" author="wmo:N8235
	replace arrival	arid=9	chan="sz"
13	append arrival	arid=11	ftid=1 qual="e" phase="S" time=193002.5 date=1978265 sta="ARR" author="wmo:N8235
14	append arrival	arid=12	ftid=1 phase="MSE" time="193008.0 amp=75.2 per=4.0 date=1978265 sta="ARR" chan="se" author="wmo:N8235
15	append arrival	arid=13	ftid=1 phase="MSN" time=193008.0 amp=61.0 per=4.0 date=1978265 sta="ARR" chan="sn" author="wmo:N8235

16	append arrival	arid=14	ftid=1 phase="MSLPE" time=193009.0 amp=216.0 per=9.0 date=1978265 sta="ARR" chan="le" author="wmo:N8235
17	append arrival	arid=15	ftid=1 phase="MSLPN" time=193009.0 amp=135.0 per=9.0 date=1978265 sta="ARR" chan="ln" author="wmo:N8235
18	append arrival	arid=16	ftid=1 qual="e" phase="SS" time=193711.0 amp=61.7 per=4.7 date=1978265 sta="ARR" author="wmo:N8235
19	append arrival	arid=17	ftid=1 phase="SS" time=193711.0 amp=192.0 per=12.0 date=1978265 sta="ARR" chan="lz" author="wmo:N8235
	replace arrival	arid=16	chan="sz"
20	append arrival	arid=18	ftid=1 phase="LRZ" time=194841.0 date=1978265 sta="ARR" chan="lz" author="wmo:N8235

21	append arrival	arid=19	ftid=1 phase="MLR" time=195407.0 amp=271.0 per=22.0 date=1978265 sta="ARR" chan="lz" author="wmo:N8235
	replace arrival	arid=18	amp=271.0 per=22.0
22	append arrival	arid=20	ftid=1 phase="M1L" time=195637.0 amp=135.0 per=10.0 date=1978265 sta="ARR" chan="lz" author="wmo:N8235
23	append arrival	arid=21	ftid=1 phase="M2L" time=195311.0 amp=200.0 per=20.0 date=1978265 sta="ARR" chan="lz" author="wmo:N8235
24	append arrival	arid=22	ftid=1 phase="M3L" time=195203.0 amp=105.0 per=30.0 date=1978265 sta="ARR" chan="lz" author="wmo:N8235
25	append arrival	arid=23	ftid=1 phase="M4L" time=195012.0 amp=98.0 per=40.0 date=1978265 sta="ARR"

			chan="lz" author="wmo:N8235
26	append arrival	arid=24	ftid=1 phase="NOISE" time=194341.0 amp=12.0 per=20.0 date=1978265 sta="ARR" chan="lz" author="wmo:N8235
27	append arrival	arid=25	ftid=1 phase="LQ" time=194251.0 date=1978265 sta="ARR" author="wmo:N8235
28	append arrival	arid=26	ftid=1 phase="MLQE" time=194302.0 amp=220.0 per=21.0 date=1978265 sta="ARR" chan="le" author="wmo:N8235
29	append arrival	arid=27	ftid=1 phase="MLQN" time=194302.0 amp=172.0 per=21.0 date=1978265 sta="ARR" chan="ln" author="wmo:N8235
30	append feature	ftid=1	cmpx=23.02 spmm=2.45
31	replace arrival	arid=1	slow=4.8 seaz=226.0 dist=94.0
32	append origin	orid=1	lat=-35.0

			lon=-120.0 time=190541.0 mb=6.5
33	replace arrival	arid=6	slow=4.8 seaz=221.0
34	replace origin	orid=1	ms=6.4 mo=6.6
35	reestablish sta="ARR" establish new ftid=2		
36	append arrival	arid=28	ftid=2 phase="S" time=235810.0 date=1978265 sta="ARR" author="wmo:N8235
37	append arrival	arid=29	ftid=2 phase="MSE" time=235816.2 amp=46.7 per=2.8 date=1978265 sta="ARR" chan="se" author="wmo:N8235
38	append arrival	arid=30	ftid=2 phase="MSN" time=235816.2 amp=53.2 per=2.7 date=1978265 sta="ARR" chan="sn" author="wmo:N8235
30	close files update counter		

APPENDIX B. HELP SYSTEM HIERARCHY

The following is the initial layout of the help system hierarchy:

User's Guide
to the
Center for Seismic Studies
Outline

1.0 Introductory User's Guide
1.1 Overview
1.2 Building Access Procedures
1.3 Computer Access Procedures
1.3.1 Local Computer Access
1.3.2 Remote Computer Access
1.3.3 Seismic Analyst Station Access
1.3.4 Classified Computer Access
1.4 Computer Operations Procedures
1.5 Database Access Procedures
1.6 Tape Library Access Procedures
1.7 Film Library Access Procedures
1.8 On-line Documentation Access Procedures
1.9 Hard-copy Documentation Access Procedures
1.10 Personnel Resources
1.11 Restaurants

2.0 Seismic Databases
2.1 Overview
2.2 Seismic Database Structure
2.2.1 Overview
2.2.2 Events - list of hypocenters
2.2.3 GDSNxxx - indices to GDSN waveform data archives
2.2.4 Explosions - information on non-natural seismic events
2.2.5 Yield - information on certain seismic events of special interest
2.2.6 IDCE - indices to October 10, 1980 international seismic experiment waveforms and parameter data
2.2.7 Demo - small sample database used with the tutorial
2.3 Seismic Database Relations
2.3.1 Overview
2.3.2 Arrival - seismic signals observed at particular stations
2.3.3 Assoc - connections of arrivals to origins
2.3.4 Event - connections of related multiple origins
2.3.5 Origin - geographic locations from which waveforms emanate
2.3.6 Wfdisc - indices to waveforms stored on disk
2.3.7 Wftape - indices to waveforms stored on tape
2.3.8 Tape - bookkeeping information on seismic data tapes
2.3.9 Secondary Relations
2.3.9.1 Overview
2.3.9.2 Explo - information on explosion sources
2.3.9.3 Moment - moment tensors for origins
2.3.9.4 Centryd - information on centroid locations
2.3.9.5 Fplane - fault-plane solutions for origins

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2.3.9.3 Moment - moment tensors for origins
2.3.9.4 [illegible] - information on centroid locations
2.3.9.5 Fplane - fault-plane solutions for origins

2.3.9.6 Extra - for remarks and extra information on attributes
2.3.9.7 Feature - related group of arrivals from particular events
2.3.9.8 Origerr - error estimates of parameters in origin relation
2.3.9.9 Stalog - seismic station status information
2.3.10 Reference Relations
2.3.10.1 Overview
2.3.10.2 Channel - orientations of components or beams of seismometers
2.3.10.3 Station - information on seismic stations
2.3.10.4 Gregion - geographic region information
2.3.10.5 Sregion - seismic region information
2.3.10.6 Date - epoch time of the start of the day
2.3.10.7 Codes - definitions of attribute codes
2.3.10.8 Counter - next sequential id for data objects
2.4 World Map Databases
2.4.1 Overview
2.4.2 World Data Bank 1
2.4.3 World Data Bank 2
2.4.4 Country Codes
2.5 Seismic Tape Library
2.6 Seismic Film Library

3.0 Seismic Application Programs
3.1 Overview
3.2 Seismic Data Manipulation
3.2.1 Overview
3.2.2 Accessing Ingres Seismic Databases with Ingres
3.2.3 Seismic Data File Creation Programs
3.2.3.1 Overview
3.2.3.2 Build - produce an external file database
3.2.3.3 Bulletin - event bulletin program
3.2.3.4 Cpevent - copy parameters from an Ingres database
3.2.3.5 Cpout - process dearchive requests
3.2.4 Seismic Data File Manipulation Programs
3.2.4.1 Overview
3.2.4.2 Aa - automatic association
3.2.4.3 Blddat -
3.2.4.4 Bps - Chebyshev bandpass filter
3.2.4.5 Dareq - process dearchive requests
3.2.4.6 Dp - seismic signal detector
3.2.4.7 Pdp - find first arrival on a windowed or continuous seismograph
3.2.4.8 Predar - predict arrivals
3.2.4.9 Reap - remove duplicates from arrival file
3.2.4.10 Renum - renumber arrival and feature id's in an arrival file
3.2.4.11 Wdcat - combine and make directories of waveforms
3.2.4.12 Wfcopy - make copies of disk resident waveform data
3.2.4.13 Wfiedt - screen editor for waveform indices
3.2.5 Seismic Data Tape Manipulation Programs
3.2.5.1 Overview
3.2.5.2 Arcprm - write parameters on archive tapes
3.2.5.3 Arctwo - write waveforms on archive tapes
3.2.5.4 Detwo - selectively recover data from archive tapes
3.2.5.5 Dmparc - recover data from archive tapes
3.2.5.6 Dsdac -
3.2.5.7 Preview - predict how much tape an Arctwo run will use
3.2.5.8 Rdaftfc -

3.2.5.9 Rdgdsn - read SRO and GDSN tapes
3.2.5.10 Rdgrf -
3.2.5.11 Rdscars - read SCARS format tapes
3.2.5.12 Rdsdac - read SDAC/SRC subset format data
3.2.5.13 Rdnrs -
3.2.5.14 Stubtap -
3.2.6 External File Access Subroutine Libraries
3.2.6.1 Overview
3.2.6.2 Parameter Data Header Files for C Programs
3.2.6.3 C and Fortran Subroutines for Accessing Parameter Data Files
3.2.6.4 C and Fortran Subroutines for Accessing Waveform Data Files
3.2.7 Waveform Index Access Subroutine Library
3.2.7.1 Overview
3.2.7.2 Cmp_wfi_sct - compare index structures
3.2.7.3 Find_wfi - search for waveform index based on start/end time
3.2.7.4 Free_wfi - free waveform index buffers
3.2.7.5 Pstalst - print a station/channel list
3.2.7.6 Scan_wfdisc - read in a wfdisc file
3.2.7.7 Scan_wftape - read in a wftape file
3.2.7.8 Sta_chan_lst - produce a list of unique station/channel
3.2.7.9 Window_wfi - update start and end time of waveform segment
3.3 Seismic Data Display Programs
3.3.1 Overview
3.3.2 Disp - interactive waveform display and analysis (Megatek 7000)
3.3.3 Wdisp - view .w formated waveforms (Tektronix 4014)
3.3.4 Snif - signal to noise interactive filtering (Megatek 7250)
3.3.5 Focal - interactive focal plane filtering (Megatek 7250)
3.3.6 Globe - interactive 3D map display of the world (Megatek 7250)
3.3.7 Hypermap - interactive 2D map projection (Megatek 7250)
3.3.8 Rayt - interactive ray path and travel time calculation (Megatek 7250)
3.4 Time and Geographic Processing Programs and Subroutine Libraries
3.4.1 Overview
3.4.2 Dlaz - distance, azimuth and back azimuth between two points program
3.4.3 Etoh - epoch to human time conversion program
3.4.4 Htoe - human to epoch time conversion program
3.4.5 Reg - region number and name program
3.4.6 Sta - seismic station information program
3.4.7 Tt - travel time table program
3.4.8 Epoch and Travel Time Conversion and Computation Subroutine Library
3.4.8.1 Overview
3.4.8.2 Doy - operate on dates and times
3.4.8.3 Dtoepoch - convert julian date to epoch time
3.4.8.4 Ellip - initial-p arrival time correction for earth's ellipticity
3.4.8.5 Etoh - epoch time to human time conversion
3.4.8.6 Getdate - convert time and date from ASCII string
3.4.8.7 Htoe - human time to epoch time conversion
3.4.8.8 Jbptime - Jeffreys-Bullen P wave travel time
3.4.8.9 Maketime -translate time types
3.4.8.10 Mdtodate - month/day to julian date conversion
3.4.8.11 Month_day - julian date to month/day conversion
3.4.8.12 Timecon - time string to epoch conversion
3.4.8.13 Timeprint - print time structure
3.4.8.14 Todaysdate - return todays date (GM time)
3.4.8.15 Ttime - Jeffreys-Bullen and Herrin travel times and derivatives
3.4.8.16 Zh_today - return time for zero hour today

3.4.9 Geographic and Seismic Region Calculation Subroutine Library
3.4.9.1 Overview
3.4.9.2 Cdelaz - distance, azimuth and back azimuth between 2 points
3.4.9.3 Greg - geographic region name given region number
3.4.9.4 Gresid - computes distance, azimuth, and residual of an arrival
3.4.9.5 Gtos - seismic region number given geographic region number
3.4.9.6 Nmreg - geographic region number given location
3.4.9.7 Sreg - seismic region name given seismic region number
3.4.9.8 Staloc - seismic station location from USGS site code
3.5 Signal Processing Programs and Subroutine Libraries
3.5.1 Overview
3.5.2 Filtering Programs
3.5.3 Wave Simulation Programs
3.5.4 Quasi Harmonic Decomposition Programs
3.5.5 Multichannel Time Series Analysis Subroutine Library

4.0 System Utility Programs
4.1 Overview
4.2 Text Editing and Document Preparation
4.2.1 Overview
4.2.2 Ed Editor Tutorial
4.2.3 Vi Editor Tutorial
4.2.4 Emacs Editor Tutorial
4.2.5 Writer's Tools
4.2.6 Document Formatting and Indexing Tools
4.2.6.1 Overview
4.2.6.2 Formatting Text
4.2.6.3 Typesetting Text
4.2.6.4 Formatting Tables
4.2.6.5 Formatting Equations and Mathematics
4.2.6.6 Indexing Documents
4.2.7 Printing Tools
4.3 File Manipulation
4.3.1 Overview
4.3.2 Creating Files
4.3.3 Viewing Files
4.3.4 Manipulating Files
4.3.5 Manipulating Directories
4.3.6 Comparing Files
4.3.7 Searching Files
4.4 Calculation
4.4.1 Overview
4.4.2 IMSL
4.4.2.1 Overview
4.4.2.2 Analysis of Variance
4.4.2.3 Basic Statistics
4.4.2.4 Categorized Data Analysis
4.4.2.5 Differential equations; Quadrature; Differentiation
4.4.2.6 Eigensystem Analysis
4.4.2.7 Forecasting; Econometrics; Time Series; Transforms
4.4.2.8 Generation and Testing of Random Numbers
4.4.2.9 Interpolation; Approximation; Smoothing
4.4.2.10 Linear Algebraic Equations
4.4.2.11 Mathematical and Statistical Special Functions
4.4.2.12 Nonparametric Statistics

4.4.2.13 Observation Structure; Multivariate Statistics
4.4.2.14 Regression Analysis
4.4.2.15 Sampling
4.4.2.16 Utility Functions
4.4.2.17 Vector, Matrix Arithmetic
4.4.2.18 Zeros and Extrema; Linear Programming
4.4.3 Desk Calculators
4.4.4 Mathematical Functions
4.5 Graphics and Display
4.5.1 Overview
4.5.2 Terminal Handling
4.5.3 Tektronix Subroutine Library
4.5.4 Versatek Subroutine Library
4.5.5 Megatek Subroutine Library
4.5.6 Plotting Programs
4.6 Ingres Database Access
4.6.1 Overview
4.6.2 Ingres Query Language (QUEL)
4.6.3 Ingres EQUEL Database Subroutine Library for C or Fortran
4.6.4 Fortran Database Subroutine Library for Ingres
4.6.4.1 Overview
4.6.4.2 Dbfcop - copy an Ingres relation to an external file or vv
4.6.4.3 Dbfcre - create a new relation
4.6.4.4 Dbfdel - delete tuples from a relation
4.6.4.5 Dbfdes - destroy an existing relation
4.6.4.6 Dbfext - obtain the structure of an external file
4.6.4.7 Dbfpri - print a relation
4.6.4.8 Dbfrep - replace values of attributes in a relation
4.6.4.9 Dbfrfa - append data stored in an array to an Ingres relation
4.6.4.10 Dbfrfr - append tuples from relations to another relation
4.6.4.11 Dbfrta - retrieve tuples from a relation into an array of character strings
4.6.4.12 Dbfrtr - move tuples from source relations to destination relations
4.6.4.13 Dbfsav - save a relation until a date
4.7 Tape Handling
4.8 Miscellaneous
4.8.1 Overview
4.8.2 Status and Information Reporting
4.8.3 Terminal environment Handling
4.8.4 Games
4.8.4.1 Overview
4.8.4.2 Adventure Games
4.8.4.3 Guessing Games
4.8.4.4 Card and Board Games
4.8.4.5 Creating Whimsical Displays

5.0 Program Development Tools
5.1 Overview and Tutorial
5.2 Software Installation Procedures
5.3 Programming Languages
5.3.1 Overview
5.3.2 Shell
5.3.3 Fortran
5.3.4 C

5.3.5 Pascal
5.3.6 Lisp
5.3.7 Apl
5.3.8 Macro Preprocessor
5.3.9 Assembler
5.3.10 Linker/loader
5.4 Software Development Tools
5.4.1 Overview
5.4.2 Making Programs
5.4.3 Revision Control System
5.4.4 Archive Libraries
5.4.5 Debugging and Testing Tools
5.4.6 Compiler Writing Tools
5.4.7 Pretty Printing Programs
5.5 Subroutine Libraries
5.6 Time Initiated Processing; Job Scheduling
5.7 Device Handling

6.0 Communications
6.1 Overview
6.2 Local Communication
6.2.1 Overview
6.2.2 Remote login
6.2.3 Mail
6.2.4 Teleconferencing
6.3 Computer Networks
6.3.1 Overview
6.3.2 Arpanet
6.3.3 Usenet
6.3.4 Tymnet
6.3.5 ECOM
6.4 Data Exchange

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